Q & A

John C. Avise

John Avise was born and raised in Grand Rapids, Michigan. He earned a BS in fishery biology from the University of Michigan, an MA in zoology from the University of Texas, and a PhD in genetics from the University of California at Davis, before joining the faculty at the University of Georgia where he stayed for 30 years. In 2005, he took his current position: Distinguished Professor of Ecology and Evolution at the University of California, Irvine. His research touches many areas of ecology and evolution, typically using molecular markers to address topics such as genetic mating systems, phylogeography, speciation, introgression, and phylogeny. He has worked on many vertebrate species (mammals, birds, reptiles, and fishes) and some invertebrates. He has received national and international awards for career contributions to molecular ecology and evolution, genetics, conservation biology, biogeography, and ornithology. He is an elected member of the American Academy of Arts and Sciences and the National Academy of Sciences, and has served as President of the Society for the Study of Evolution, the American Genetic Association, and the Society for Molecular Biology and Evolution. He has published more than 300 scientific articles, plus 16 books (12 of which were solo-authored) on subjects ranging from natural history and evolution to genetic engineering, scientific humor, and the science–religion interface, and also the autobiography Captivating Life: A Naturalist in the Age of Genetics (2001).

Do you come from a family of scientists? No, Dad was a business graduate of Northwestern University and became a postal inspector. Mom was a graduate of Michigan State University; her career spanned ten years, mostly in the Extension service for MSU, before becoming a full-time homemaker. They were both deeply supportive of my fascination with nature, which began in childhood. I was their only child.

Can you expand on how you became infatuated with nature? I attribute a lot of that to my summers with my maternal grandmother in Michigan's Upper Peninsula. Grandma and mom were self-sufficient Swedes, basically living off nature's bounty, and they taught me many lessons. Each summer we planted a backyard garden from which we canned vegetables for the long winters. We picked wild berries for fruit and to make jellies. We had chickens for eggs and meat, a cow for milk; we fished my beloved Ice Lake, and in general we spent most of our time in the great outdoors. I had many nature hobbies, including rock and mineral collecting, bird watching, and insect collecting. Then and now, I am happiest and most content when observing nature. At the end of each summer, I dreaded my return to the Lower Peninsula for the start of the school year.

Did your interest in nature influence your college plans? Yes. I wanted to be a fisheries biologist, so I joined the School of Natural Resources at the University of Michigan. I loved the organismal courses such as ichthyology and entomology, but I had little interest in other required classes such as genetics and biochemistry. What I envisioned was an outdoor career, perhaps working for the Department of Natural Resources.

Why then did you go to graduate school? For one reason only — Vietnam. I spent much of my time at the University of Michigan trying to persuade my draft board that my moral objection to the Vietnam War was strong enough to be a religious conviction. But I had no formal religious affiliation, and my pleas for conscientious objector status fell on deaf ears. But during my senior year, the Supreme Court issued a decision that expanded what could be deemed religious opposition to war. In my case, I could get one additional year of student deferment if I entered graduate school. That's how I ended up at the University of Texas.

What happened then? Something I never anticipated. Through coursework and research, I became intellectually captivated by hard-core genetics, which at that time had just entered the molecular era with the introduction of allozyme methods to population biology. Almost everyone else in that neophyte field seemed preoccupied with the selection/neutrality debate, but I began to see another role for molecular variation — as genetic 'markers' to study animal behavior and natural history. Before the molecular revolution, genetics could be practised on only a few model organisms. In Robert Selander's laboratory, I began to see an opportunity to wed studies of natural history with molecular genetics. For the first time, molecular markers might open the whole biological world to genetic scrutiny. Today, we call these disciplines molecular ecology and molecular evolution, but those fields did not exist back then.

What did your draft board decide? Miraculously, they awarded me conscientious objector status in mid-1971. I was delighted, but that also meant that I had to find a job that met the requirements of alternative service. This job had to be in the nation's interest, have a salary below that of an Army inductee, and entail physical danger or discomfort. I ended up working for two years at the Savannah River Ecology Lab (SREL) in South Carolina. How that came about is an interesting story.

While at the University of Texas, I met Michael Smith, who was from SREL but doing a sabbatical in Selander's lab. When Mike learned of my job predicament, he offered me a lab-tech position at SREL. He then wrote to my draft board explaining how this job should qualify for alternative service: it would be in the national interest, because a big part of SREL's mission was to monitor thermal effluents and radioactivity from the nearby atomic reactors that produce tritium for nuclear weapons. The job also was dangerous, because one of my weekly duties was to tromp through a snake- and alligator-infested swamp to collect biological samples for genetic and radioactivity analyses. My draft board accepted the argument. The job was all that Mike claimed, but I loved it. Every day brought a new opportunity to collect specimens and analyse them genetically in a protein-electrophoresis lab that I set up. Mike gave me great freedom to design

scientific projects, and this resulted in several publications. It was like being a postdoc while still a predoc.

By then, I was hooked on the idea of addressing natural history from a genetic perspective. A prominent scientist who seemed to share this vision was Francisco Ayala at the University of California, Davis. Francisco proved to be a wonderful mentor, and a scientific role model for much of what I have attempted to accomplish in my career. I obtained a PhD under his tutelage, and then took a faculty position at the University of Georgia.

A big part of your career has been devoted to mitochondrial (mt)DNA and developing the field of phylogeography: how did you become involved with mtDNA? That's an interesting story too, and it highlights the role of serendipity in science. After giving a departmental seminar at the University of Georgia in the mid-1970s, I closed by asking the audience whether anyone could suggest how I might study regulatory loci, which were suspected to play a role in adaptive evolution. Someone in the audience asked whether I had contemplated using restriction enzymes to screen repetitive DNA. I hadn't heard of restriction enzymes, but I soon read papers and concluded that these enzymes might be great molecular tools. So, I asked several biochemists at the University of Georgia if I could work briefly in their lab to learn restriction procedures. Everyone politely said "no" except Bob Lansman, whose career was devoted to the physiology and function of mtDNA.

I had barely heard of mtDNA either, but without other options I agreed to work with Bob. After conducting many restriction digests on mtDNA from mice and other mammals, we began to appreciate that this molecule had very special properties (such as matrilineal inheritance and rapid sequence evolution). I abandoned prior thoughts about studying gene regulation, and began to capitalize on the genealogical data that mtDNA could provide. This led eventually to the field of phylogeography, which I have argued was one of the major advances in biology in the latter half of the 20th century. Phylogeography has opened empirical and conceptual bridges between population genetics and phylogenetic biology, two research realms that previously had little contact.

Are you still working on phylogeography today? We still do an occasional phylogeographic study, but more than a decade ago I shifted our research focus to genetic parentage and mating systems of fishes and other creatures. We mostly use microsatellites for this purpose.

Why did you switch fields like that? I had been doing phylogeographic work for nearly 20 years, and wanted a change. Also, I thought that the major principles of phylogeography probably had been elucidated by that time, and that to move the field forward would require skills I did not possess — mathematical expertise to elaborate a multi-locus coalescent theory, or molecular expertise to develop empirical approaches to reconstruct gene trees for nuclear loci. I also reckoned that pursuing either of those research avenues would lead me away from natural history. In the 1990s, microsatelllite assays had just been introduced, and their power for maternity and paternity analysis was evident. I thought that moving my lab in that direction might offer opportunities to advance science and to return to my natural history roots. Fish and many other vertebrates and invertebrates have fascinating mating behaviors in nature that are fun to dissect with genetic markers. I'm glad I made the switch — it led to a scientific gold mine of research opportunities.

You've worked with literally hundreds of different species during your career: do you have a favorite? That's a tough question. I'll always have special fondness for the blind cave fish from Mexico that got my career started at the University of Texas. Similarly, I'll always have a special fondness for sunfish, field mice, and pocket gophers because they were the subjects of research papers important early in my career. Any list of my favorite creatures also would have to include marine turtles, because of their amazing migratory behaviors and natural histories; pipefishes and seahorses, because of the phenomenon of male pregnancy; armadillos, because they produce clonal sibships routinely, via polyembryony; mangrove killifish, because they are self-fertilizing hermaphrodites; American eels, because of their catadromous lifestyle (they breed in the sea and the juveniles then disperse to freshwater streams); corals and sponges, because of their beauty and their capacity to distinguish self from non-self in their histocompatibility responses to tissue grafts; horseshoe crabs because of their status as living fossils; and any of the unisexual vertebrates that consist solely of females who reproduce by virgin birth. Last but not least, I'd have to add in birds. I've taught ornithology throughout my career, done much research on birds, been an avid birder, and birds generally are beautiful, wonderful creatures. I would not want to imagine a world without them.

You have also written many textbooks and trade books: how do you manage to do that while also running an active research program? The trick is to get great graduate students. I've been blessed with many incredible students and research technicians. They do the real work. My job now is mostly to run advertising campaigns for their products, which means helping to write their papers, giving lectures, and writing books that synthesize scientific fields for different audiences. I think that my research experience with so many different creatures helps me to see connections that otherwise might be less apparent, and to interpret the biological world from a comparative vantage.

Do you have a favorite among the books you have written? I'll always have a special fondness for *Molecular Markers, Natural History, and Evolution*; before then, I never imagined that I would be capable of such a synthesis. Perhaps the best book I have written is *The Genetic Gods: Evolution and Belief in Human Affairs*. I'm quite proud of that one, which deals with the interface between evolutionary genetics and religion.

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